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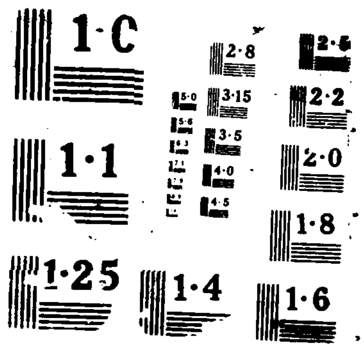
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Work by R.H. Rediker and his collaborators is summarized here.

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operating characteristics for these processors have also been obtained, and used to quantify a variety of resolution/performance trade-offs for these systems. Two of the key assumptions in the preceding analysis are being relaxed in a follow-up study,[2] experimental confirmation of the processor performance theory will be sought in future measurements using the M.I.T., Cambridge, Mass. Lincoln Laboratory 2-D pulsed imager laser radar test bed.

Unconventional Laser Radars

We have begun a theoretical study of the combined effects of target speckle, local-oscillator shot noise, and laser frequency instability on a variety of unconventional laser radars, i.e., radars which use range and/or Doppler measurements to perform imaging with spatial resolution beyond the diffraction-limit of the radar optics.[3] Thus far we have completed spatial resolution, carrier-to-noise ratio (CNR), and signal-to-noise ratio (SNR) assessments for 2-D and 3-D synthetic aperture systems. Additional work is underway on range-Doppler imaging and inverse Fourier transform imaging.

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[1] M.B. Mark, "Multipixel Multidimensional Laser Radar System Performance," Ph.D. Diss., Dept. of Electr. Eng. and Comp. Sci., M.I.T., Cambridge, Mass., 1986.

[3] S.M. Hannon, "Analysis of Quasi-Optimal Multipixel Laser Radar System Processors," S.M. Thesis proposal, Dept. of Electr. Eng. and Comp. Sci., M.I.T., Cambridge, Mass., 1986.

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6.4 Fiber-Coupled External-Cavity Semiconductor High Power Laser

U.S. Navy - Office of Naval Research (Contract N00014-80-C-0941)

Robert H. Rediker, Kristin K. Anderson, So Kuen Liew, Christopher J. Corcoran

Last year's annual report described the high spectral purity of the output from an ensemble of five discrete diode lasers when operated cw. The linewidth of the cw output of this external-cavity-controlled ensemble of diode lasers was shown to be less than 7.5 MHz ($\sim 2 \times 10^{-8}$ of the center frequency). Also reported last year was high-spectral-purity pulsed output from this external cavity controlled laser. In 1986 the pulsed operation of this laser was investigated in detail both experimentally and theoretically.

Figure 6.1 is a schematic of the external-cavity arrangement. Linewidths of the order of the 7.5-MHz instrument resolution have been obtained. To achieve this high spectral purity in a pulse mode of operation, three alternate gain elements (elements number one, three, and five in Fig. 6.1) are operated cw and the intermediate two elements are pulsed. For a coherent ensemble of only three alternate gain elements, the spacing between the major intensity maxima in the Fourier plane (the filter plane) is decreased by a factor of 2 relative to the spacing with all five elements operating coherently. As a result, the lasing threshold for the three-element ensemble is much higher because significant radiation hits the opaque areas of the filter. A calculation of the single-pass filter transmission for this case yields a value of 0.48 as compared to the transmission of 0.92 when all five elements are running.

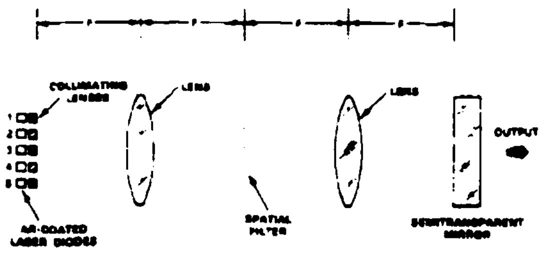


Figure 6.1. : Schematic of multiple-element external-cavity arrangement showing the placement of the five antireflection-coated diode lasers, the associated collimating optics, the two lenses, spatial filter, and end mirror. As indicated on the figure, the elements are seperated by the focal length of the lenses so the light undergoes a Fourier transform four times during one round trip through the cavity.

The spectral output of the ensemble when operated with current pulses applied to elements number two and four and cw excitation to the other three was measured for two different cases. First, the dc biases on the two pulsed elements were set so the laser ensemble was just above threshold when the pulse was off. In this case, the spectrum for the pulse output remains at the value set by the low-level cw output of the external cavity. The linewidth in this case is within the 7.5-MHz instrument resolution. It should be pointed out that if any of the five external-cavity lasers operating independently without the spatial filter are pulsed from below threshold, there is a 1-Å (≈40 GHz) output frequency shift (chirp) during the pulse, and there is still a chirp larger than 1.5 GHz if all five elements of the coherent ensemble with the spatial filter are pulsed simultaneously from above the ensemble threshold. For the second case, the dc biases on the two pulsed elements were reduced to a point where the ensemble was well below threshold with the pulse off. The measured linewidth is 9 MHz.

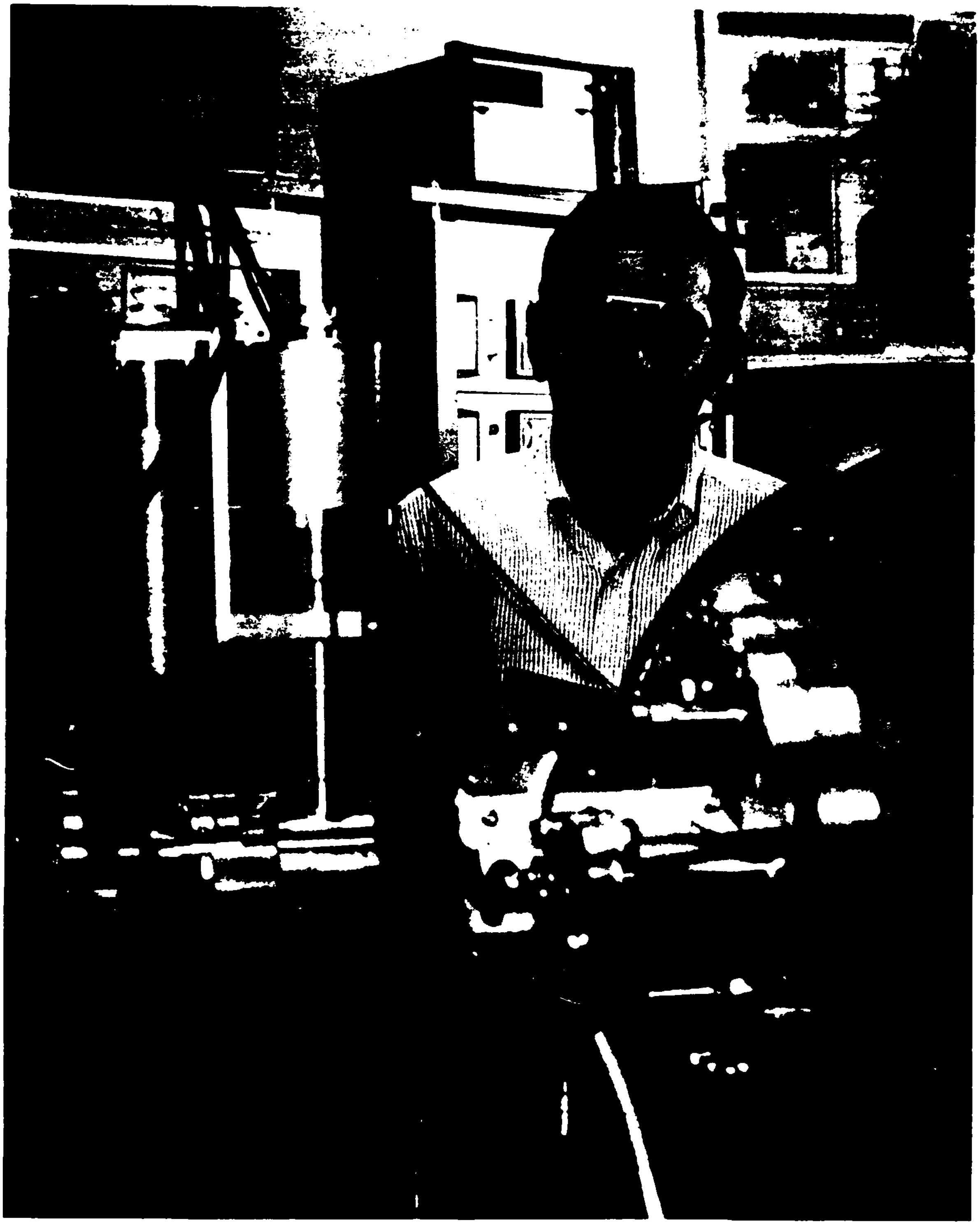
The narrow linewidth pulses can be explained by a compensation effect. Refractive index and gain in pulsed elements two and four are changing because of increased temperatures and carriers caused by the increased current. In the other three elements, however, changes occur in the opposite direction because of decreased temperatures and carriers and the simultaneous decrease in carrier lifetime.

A third case which has implications for an all-optical repeater is to operate elements one, three and five at a high enough level so this ensemble of alternate elements is just below threshold. A very small pulse output from elements two and four brings the entire ensemble above threshold with an output pulse well over a factor of 100 (20 dB) larger than the input pulse. The practical implementation of this all optical repeater would surely be different from the sketch of Fig. 6.1, but would use the same principle of obtaining gain by changing the spatial configuration of the electromagnetic field in the Fourier plane.

Publications

[1] K.K. Anderson, R.H. Rediker, and L.J. Van Ruyven, "Pulsed Operation of an Array of Diode Lasers with Feedback in the Fourier Plane and a Chirp Less Than 7.5 MHz Measurement Resolution," Technical Digest of 6th Topical Meeting on Intergrated and Guided Wave Optics (IGWO), Atlanta, Georgia, February 1986, p. 30.

[2] K.K. Anderson and R.H. Rediker, "High Spectral Purity cw and Pulsed Output from an Ensemble of Discrete Diode Lasers," Appl. Phys. Lett. *50,* 1 (1987).



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